THE RATON MESAS OF NEW MEXICO AND COLORADO*

By WILLIS T. LEE
U. S. Geological Survey

The Raton mesas, or table-lands, are situated east of the Rocky Mountains in southern Colorado and northern New Mexico. They occupy a belt 25 miles or more in width extending from the town of Raton, N. Mex., which is situated about forty-five miles east of the foothills proper, eastward into Oklahoma a distance of nearly 100 miles. They differ greatly in size. Some rise only a few feet above the general level of the plain on which they rest, others more than 3,000 feet above this plain.[1]

There is difference of opinion as to the name appropriate for this group of mesas. A few writers have used the name "Mesa de Maya" as a collective term after the largest of the group. Others use the term "Raton Mesas," adopted from the loftiest and best known of the group. The latter conforms to local usage, and "Raton Mesas" is the term used generally in the thickly populated region near the western end of the group, whereas few people have ever seen Mesa de Maya. The term "Raton Mesas" is also used by the U. S. Geological Survey, which now employs the term "Raton Mesa region."

The word "mesa," meaning table, is used in the southwestern part of the United States almost exclusively in place of table-land, and most of the mesas would be called table-lands or plateaus in other parts of America. However, the term is applied rather loosely; and in many instances terraces, benches, and other types of land form are called mesas.

The Raton mesas are all true table-lands, having flat tops and precipitous slopes on all sides. The surface from which they rise is a part of the Great Plains, which at the western end of the mesa region is about a mile above sea level. This surface falls gently away from the mesas to the south, east, and north; and the streams rising in these highlands radiate from them in these three directions, winding over the mile-high plain for considerable distances before dropping into the narrow canyons, some of which are more than 1,000 feet deep.

There are three major surface levels, which give the mesa region the form of a broad complex pyramid: a lowland plain south of the 1,000-foot Canadian escarpment, which extends from a point south of Las Vegas northeastward past Clayton, N. Mex.; an upland plain between this scarp

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[1] This article deals with the physiography of an interesting region the human aspects of which were touched on in the article by Charles R. Keyes: The Hanging Gardens of the Mesa de Maya, *Geogr. Rev.*, Vol. 8, 1919, pp. 145–152.

corresponding to the Canadian escarpment and the mesas; and the high table-lands, or Raton mesas, which culminate in Fisher's Peak. Toward the east and north there is no intermediate scarp corresponding to the Canadian escarpment, and the plain slopes gradually from the foot of the mesa scarp to the level of the Arkansas River, whose valley in relations corresponds in a general way to the broad Canadian valley south of the great scarp.

The mesas are remnants of erosion, parts that were not worn down to the general level of the Great Plains. Their shape results from the character of the rock composing them. Each mesa has a table top, or cap rock, of hard basalt which was poured out from numerous volcanic vents as molten lava at a time when the general surface of southern Colorado and northern New Mexico was relatively much higher than now. Under the lava cap are comparatively soft shale (Cretaceous) and coal-bearing shale and sandstone (chiefly Tertiary). Because these easily eroded rocks are protected by sheets of hard cap rock, the mesas maintain steep sides as they are slowly eroded away.

The larger mesas rise to altitudes ranging from 7,500 to 9,500 feet above sea level, or 1,000 to 3,000 feet above the surface of the plains. In consequence of the altitude rain falls on the mesas while the lower plain around remains parched and dry. It is no uncommon circumstance for a mesa top to be shrouded in cloud for considerable periods and kept moist as if drenched with heavy dew. During my survey work on Johnson Mesa a rainy night was followed by foggy weather and a slow drizzle of rain. No outdoor work could be done, and towards noon we started for Raton. On reaching a point a few hundred feet below the rim of the mesa we passed below the fog or cloud and about two miles from the rim encountered bright sunshine. But the top of the mesa remained shrouded in cloud most of the day.

But while the mesas are high enough for frequent summer showers they are also high enough for disastrous frosts in late spring and early fall and for heavy winter snows.

Some one has said that mesas are inverted oases. If an oasis is a "hole in the ground," as Mark Jefferson has said, a mesa may be termed a "hole in the sky." The Raton mesas are productive areas in the desert realm of cloud, for they are not so high as to be barren on account of the cold. Some of them are used for grazing, others for tillage. As grazing areas they have both advantages and disadvantages. There are practically no trees on the mesa tops, although the sides are well forested except where the slopes have been stripped for lumber or firewood. Grass grows luxuriantly, but if the cattle are not brought down before snow falls many of them die from exposure and from accident on the steep slippery trails. Another drawback to the mesas as pasture lands lies in the electric storms, for many an animal is killed there by lightning. During our work on the mesas, where we traveled chiefly on horseback, we soon learned to dismount and seek low ground at the first flash of lightning.

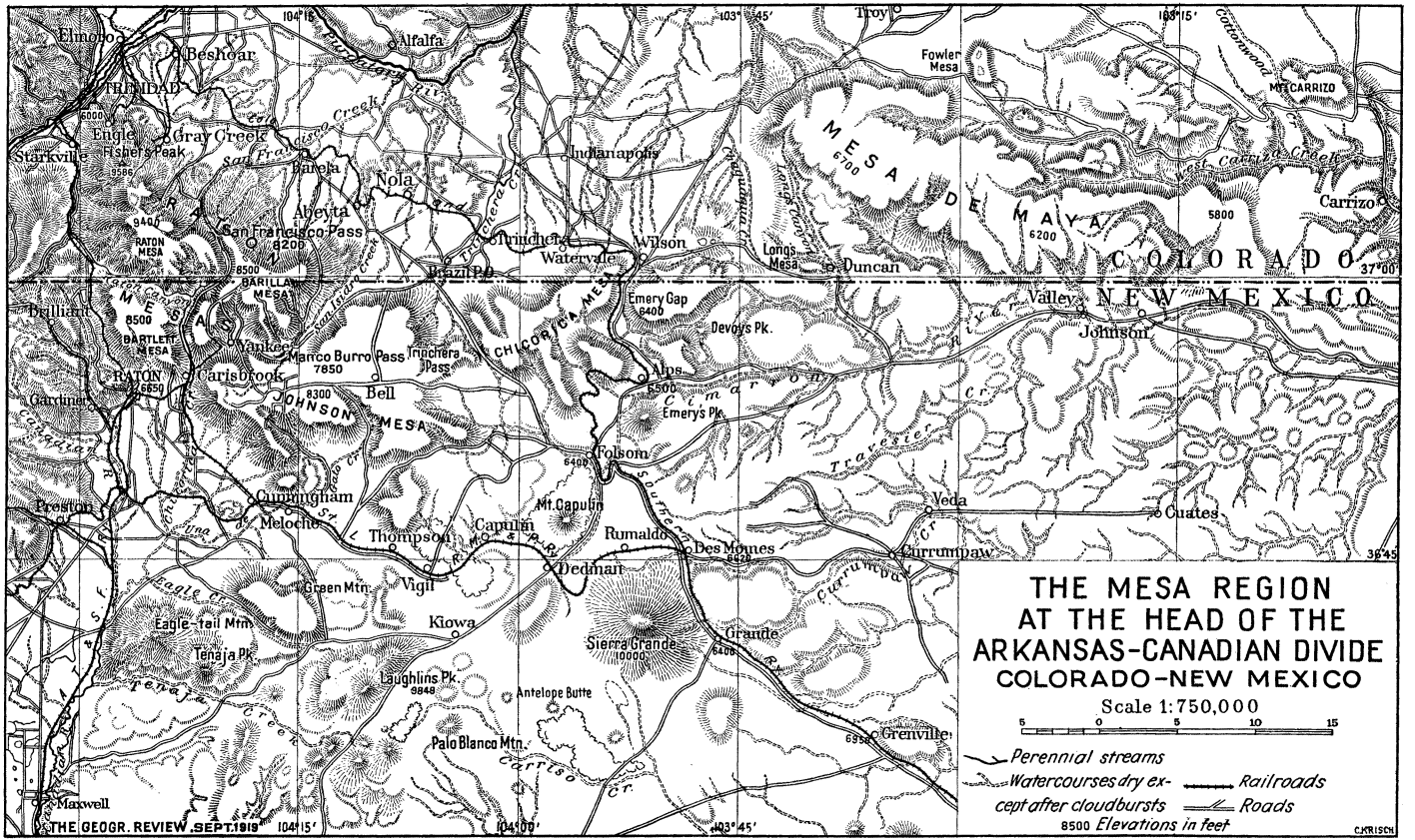

FIG. 1—Map of the Raton Mesa region. The term Raton Mesas is used both in a restricted sense, as on the map, and in a collective sense for the entire region. The latter is the usage of the U. S. Geological Survey (see U. S. Geol. Survey Prof. Paper 101, 1917). The sources upon which the map is based are of unequal value: only a third of the area is covered by topographic sheets of the U. S. Geological Survey. For detailed note on sources see footnote on p. 145, *Geographical Review*, Vol. 8, 1919.

Johnson Mesa is the one most extensively used for agriculture, and thousands of acres of its surface are under cultivation. The rich black soil derived from the disintegration of basalt produces good crops of hay and grain and such other products as can withstand the rigors of the climate. But the communities, although within sight of the through lines of traffic, are really far from them, and the traveling public knows little of these dwellers among the clouds. From their lofty stations the mesa men gaze unobserved over broad fields of activity. The Colorado and Southern Railway, which connects Denver with the Gulf of Mexico, skirts the mesas on the north and east; and the Santa Fe Railway, one of the chief transcontinental thoroughfares, on the west and south.

The mesas owe their existence to volcanic activity. Ages ago molten basalt flooded the surface and hardened into resistant layers. Where the soft older rock was not covered with lava it was worn down by rain and stream, and a lower plain was formed. The lava outpoured on this lower plain, and again the surrounding country was eroded away. This process continued and resulted in a number of lava-covered benches such as those shown in Figure 5, page 390. There are three well-marked and conspicuous benches and several less extensive ones. Each has its distinguishing characteristics, chiefly volcanic. Hence a study of the mesas is largely a study of a great but little-known volcanic district.

Features of the Mesa Region Observed from the Santa Fe Railway

Travelers over the Santa Fe route pass through Trinidad, Colo. Those interested in natural objects will notice a conspicuous height of land which rises about 3,600 feet above this station. It is called Fisher's Peak, although in reality it is not a peak, properly speaking, but only the projecting point of Raton mesa, the peaklike appearance being due to perspective. The main part of the high table-land of Raton Mesa is beyond the point and cannot be seen. The blocklike appearance of the top of Fisher's Peak is due to the lava cap, about 600 feet thick, which consists of several sheets of basalt. This cap of hard rock rests on soft, easily eroded sandstone and shale containing the beds of coal that make the Raton Mesa region one of the most important coal-mining centers in western America.

On leaving Trinidad the westbound train with two extra engines as helpers toils laboriously up the steep, winding grade to Raton Pass—a climb so difficult that in order to divert heavy traffic from it a new Santa Fe line was constructed across half of New Mexico and parts of Oklahoma and Texas.

For many miles Fisher's Peak is the most conspicuous object of the landscape. At its base lies Starkville, the first coal-mining town passed on the route. The coal is taken from under Fisher's Peak, and the mine workings extend through the northern part of the mesa and emerge on the

opposite side. Three other coal-mining towns are passed on the way to the crest, where the traveler crosses the state line into New Mexico and plunges almost immediately into a tunnel which penetrates the highest ridge of the pass. The last mine before the tunnel is reached is named for Dick Wootton, an early scout, Indian fighter, and associate of Kit Carson. At a time long before the railroad was built, when this part of the country was full of hostile Indians and still more hostile "bad men,"

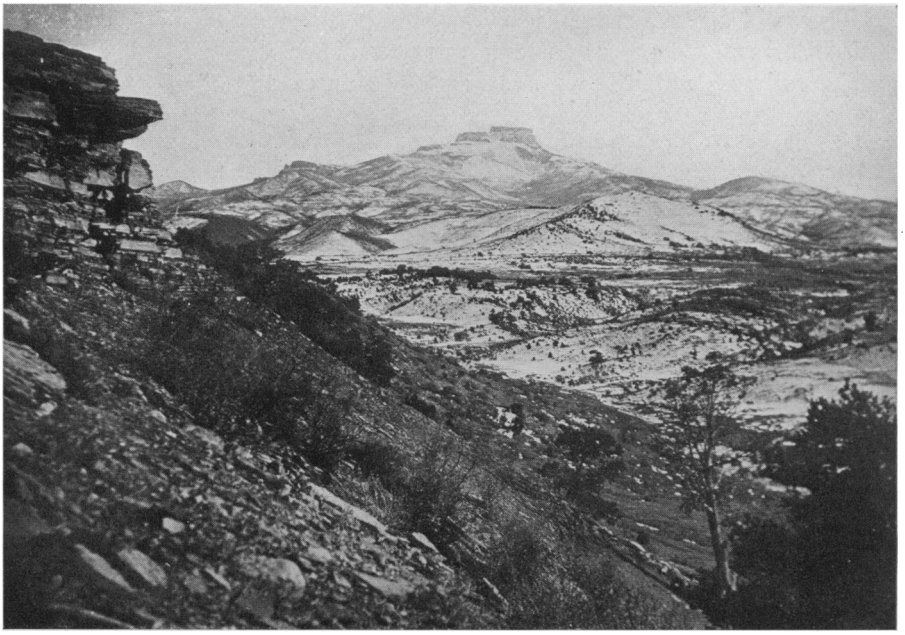

FIG. 2—Fisher's Peak as seen from a point near Trinidad, Colo. The "peak" rising 3,600 feet above the town is the point of Raton Mesa whose flat top is maintained by sheets of hard basaltic lava.

Wootton constructed a toll road over Raton Pass and at his headquarters collected toll from those whom he could persuade to pay. Be it said, however, that he reached opulence and a ripe old age, in part by virtue of not seeing and hearing things which did not immediately concern him, and in part by his well-known ability to defend his interests against all comers. From the tunnel southward the road skirts Bartlett Mesa and at the town of Raton is again on the plain which was left at Trinidad.

From points south of Raton a variety of interesting natural features may be observed. To the east Johnson Mesa rises boldly from the plain. Farther south is a large group of volcanic mountains. Mt. Laughlin may be recognized by its smooth oval form, Mt. Tenaja by its square flat head, and Eagletail by its dark-colored pointed summit. Eagletail is an old volcano. A broad cone with gently sloping sides was built long ago by molten igneous rock. Then followed a long period during which the mountain was eroded.

In relatively recent time volcanism was renewed, and a steep-sided cinder cone was formed at one side of the old crater. This cone is covered with piñon pines, which make it dark-colored and give it the appearance of being distinct from the older parts of the mountain which are devoid of trees. To the right of our route are the precipitous bluffs of coal-bearing rocks. In the sheltered nooks at the foot of the bluffs formed by streams which have cut numerous canyons in the highlands nestle the mining towns of the Raton coal field. Here is produced much of the coke used in the smelters of the Southwest.

Bartlett and Johnson Mesas

Turning attention again to the mesas proper, the one nearest to Raton is Bartlett Mesa, whose nearly flat top, six miles long and four miles wide, is about 2,000 feet above the town. The cap rock consists of columnar basalt and terminates in steep cliffs which can be scaled in few places. Near the northern rim is a volcanic cone which marks the vent through which the basaltic lava of the cap rock was extruded.

Directly east of Raton at a distance of six miles is the western end of Johnson Mesa. The main part of the mesa lies farther to the east and has not yet been mapped with the same degree of accuracy as the western end. Like Bartlett Mesa it is lava-covered and rises to a general altitude of about 8,500 feet above the sea. From this general level, however, peaks of igneous rock rise to still greater heights. Towndrow Peak, a beautifully conical mountain of pink andesite, rises about 300 feet above the general level of the mesa. A few miles east of this peak is a recently formed cinder cone, and still farther east are several other peaks of volcanic rock.

The basalt of Johnson Mesa is columnar in many places, and the rim is generally so precipitous that the expense of constructing roads and even trails is heavy. The sheets of lava are horizontal, like those shown in Figure 5, but in some places along the precipitous rim the ends of congealed lava streams are exposed where they have been truncated by erosion, showing columns radiating from the center which indicate progressive cooling from circumference towards center. Looking northward from the rim the observer obtains a beautiful view of the steplike structure of the mesas caused by alternate erosion and extrusion of lavas. Figure 6 shows two of these mesa levels.

Features of the Mesa Region Observed from the Colorado and Southern Railway

Some of the most interesting views of the mesas are to be obtained from the Colorado and Southern Railway between Trinidad, Colo., and Des Moines, N. Mex. This road skirts the high mesas for a distance of 80 miles. On leaving Trinidad the southbound traveler goes in a general south-

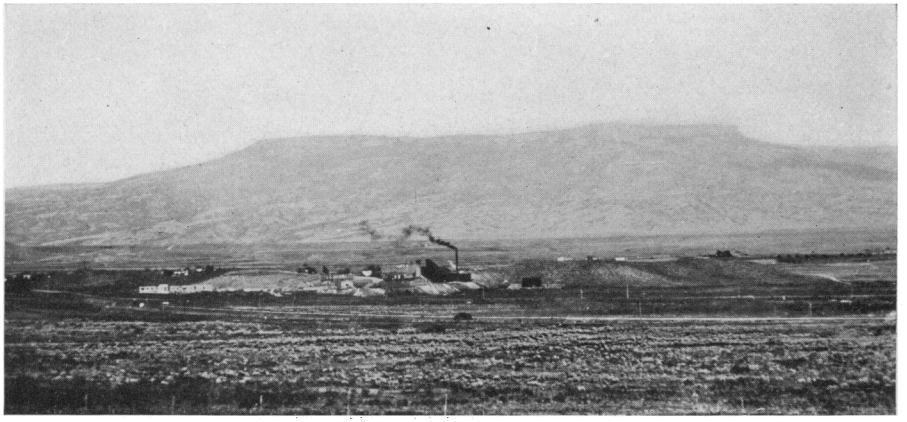

FIG. 3

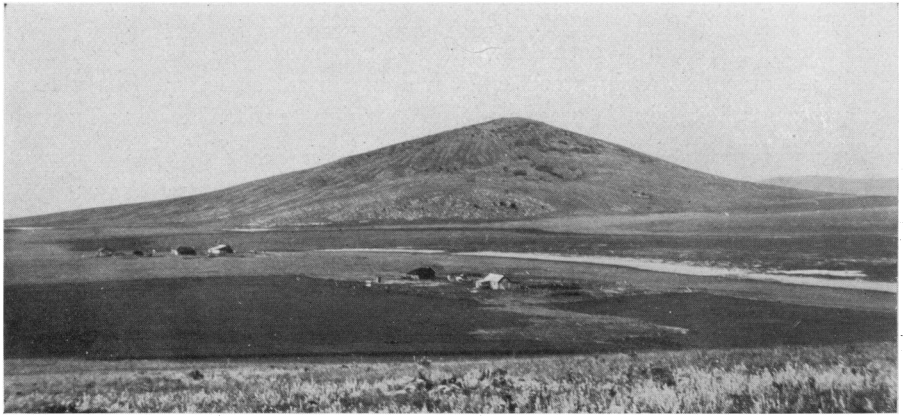

FIG. 4

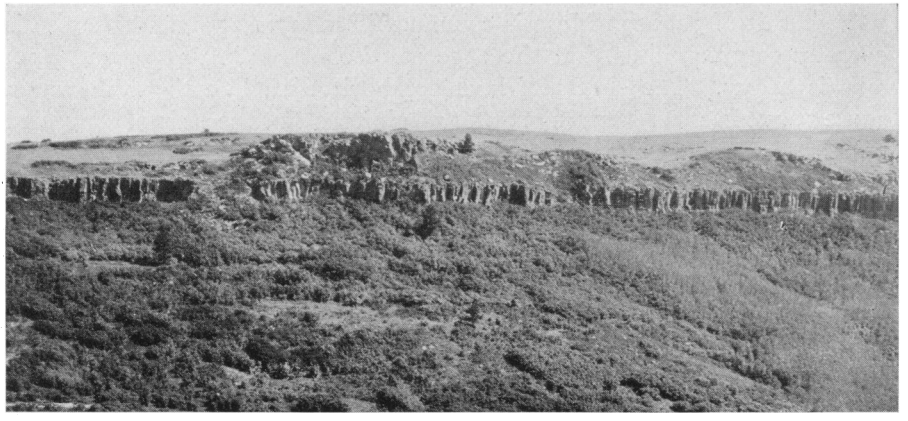

FIG. 5

FIG. 3—Johnson Mesa as seen from Raton, N. Mex.—a lava-covered table-land rising 2,500 feet above the plain on which it rests.

FIG. 4—Towndrow Peak, a conical mass of pink andesite rising 300 feet above the top of Johnson Mesa.

FIG. 5—The rim of Barilla Mesa as seen from Johnson Mesa. The cap rock is made up of several sheets of basalt.

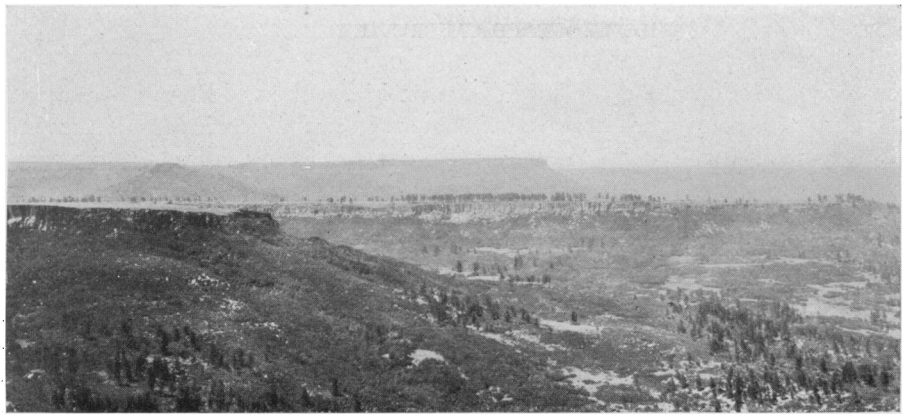

FIG. 6

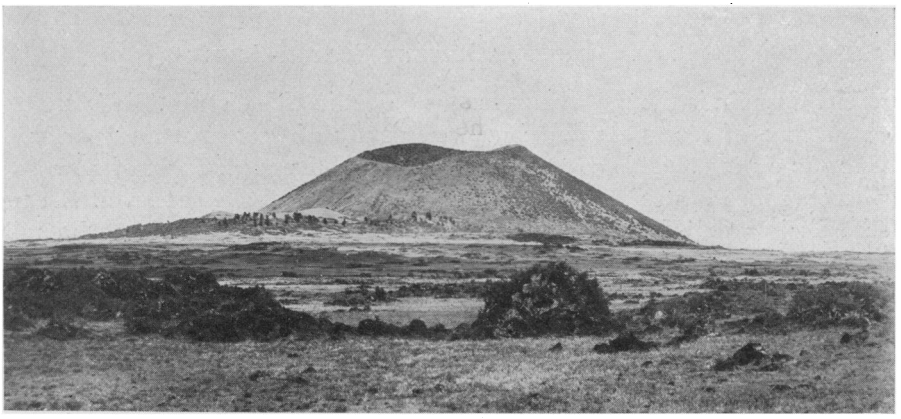

FIG. 7

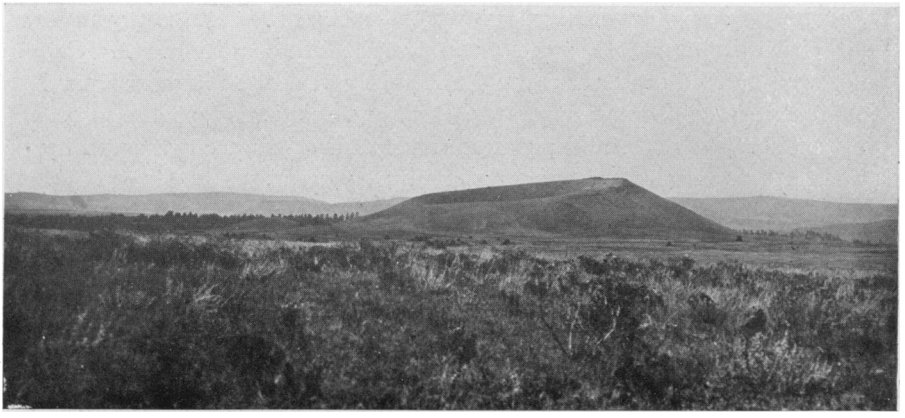

FIG. 8

FIG. 6—Parts of Bartlett Mesa in foreground and the higher older Raton Mesa in the background. Raton Mesa was partly eroded away before extrusion of the lava which now caps the younger and lower mesa.

FIG. 7—Mt. Capulin, N. Mex., a crater cone of recent origin consisting of cinders and flow lava. It is about 8,200 feet in altitude and rises 1,300 feet above the plain on which it rests.

FIG. 8—View of Baby Capulin, a very young cinder cone near Folsom, N. Mex.

easterly direction along the base of Raton Mesa, then of Barilla Mesa, and finally turns southward around the eastern end of Chicorica Mesa through Emery's Pass, which has been famed for rough going ever since the early pioneers found difficulty in urging their ox teams over this rough stretch of the old Santa Fe trail.

At this pass the traveler leaves the great Mesa de Maya on his left and winds about the eastern end of Chicorica Mesa, avoiding the rugged slopes on his right and the deep tributary gorges of the Canyon of the Dry Cimarron on his left; doubles back to the west around the head of this canyon; and finally emerges from the hills into one of the most remarkable volcanic districts in America, filled with crater cones and lava flows and a variety of minor land forms characteristic of a volcanic region.

Mt. Capulin, a Recent Crater-Cone

Mt. Capulin is the most conspicuous object in this district. It is a truncated cone of recent origin, composed partly of flow lava and partly of volcanic cinders. This cone rises 1,300 feet above a platform of flow lava whose surface lies at an altitude about 6,700 feet above sea level. In the summit is a cup-shaped depression, or crater, about a quarter of a mile across, inclined toward the west so that the eastern part of the rim is 300 feet or more higher than the western part. The crater marks the vent through which the lava of the cone reached the surface. In this respect Capulin differs from some of the conical mountains of igneous rock in this district, which show no evidence that they ever had a crater. To distinguish it and other cones of like character from conical mountains formed in other ways, the term "crater-cone" is here used to designate a cone built up around a volcanic vent by lava which reached the surface through that vent either in a molten state or in fragmental condition. As Capulin has a well-defined crater and was built partly of molten lava and partly of cinders extruded from that crater, it may be regarded as the type of a crater-cone. This splendid product of volcanism has been reserved by the United States Government as a national monument.

Many voluminous floods of lava were extruded from this great vent. One made its way down the Canyon of the Dry Cimarron for a distance of about 27 miles. Others spread out in broad sheets covering large parts of the plain. Some of these flows are so recent that little soil has accumulated on them. Caves formed by the flow of molten lava from beneath the hardening crust are numerous, and there are many domelike "blister cones" where the cooling crust buckled before the flowing mass became stationary.

From the top of Capulin a remarkable panorama opens to view. Lava flows and crater-cones, some composed of cinders and others of flow lava, appear as far as the eye can reach. Toward Folsom one gazes downward directly into the throat of two small cinder cones called Little Capulin and Baby Capulin. The latter consists of a circular rim of cinders about 200

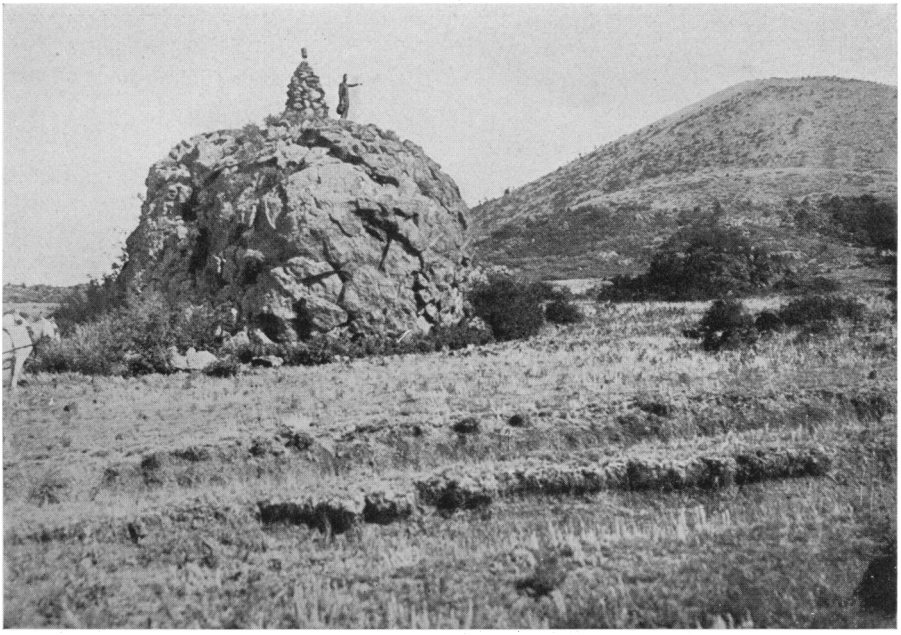

FIG. 9

FIG. 10

FIG. 9—A "blister cone" at the foot of Mt. Capulin formed by the buckling of the crust of partly cooled lava.

FIG. 10—View of lava field northeast of Mt. Capulin and of a very young volcanic vent as seen from the top of the great cone.

FIG. 11—Sierra Grande, an old, deeply eroded volcanic cone near Des Moines, N. Mex. The photograph well illustrates the approach of the characteristic violent storm commonly known as "cloud-burst."

FIG. 12

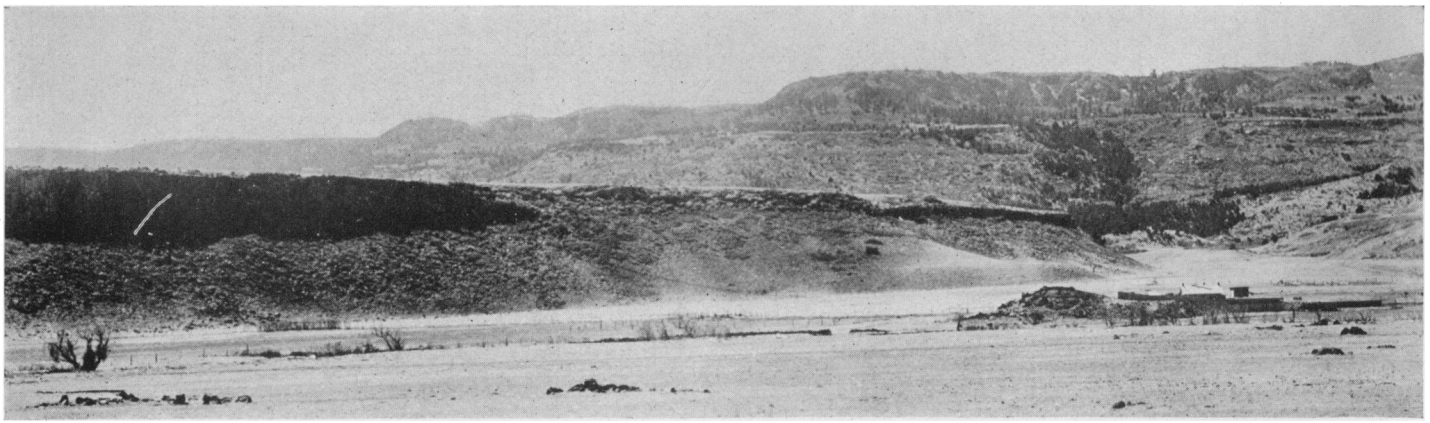

FIG. 13

FIG. 12—Mt. Robinson, a crater cone near Mt. Capulin, intermediate in age between the younger cones of the Capulin group and the old cones represented by Sierra Grande.

FIG. 13—Three generations of flow lava shown in the Canyon of the Dry Cimarron east of Folsom, N. Mex. An ancient lava flow from Mt. Emery, which is situated on the highest bench shown, entered the canyon and was partly eroded away before a recent flow covered the floor of the canyon.

feet high with a cup-shaped crater reaching down nearly to the level of the surrounding plain.

Close to the foot of Mount Capulin is a young vent which may be called an embryo volcano. To one looking directly downward from the top of Capulin this vent has the appearance of a horseshoe. On the ground it appears as a genuine crater nearly circular in outline and 200 feet in diameter. The rim consists of flow lava about 10 feet high and 20 feet wide, broken away for a space of 50 feet where the molten lava left the crater. It is doubtful if more than one flow of lava was extruded from this vent. It might be called a one-eruption crater.

It is not known when these craters were formed, but their fresh appearance indicates recent origin. It can safely be said that some score or more of the cones were formed when the general surface of the district was more than a mile above sea level. The one on Bartlett Mesa and that described from Johnson Mesa (Fig. 6) rest on surfaces about 8,500 feet above the sea. These lava flows and crater-cones should be a sufficient refutation of the statement, still frequently repeated, that volcanoes form only near the seashore.

Sierra Grande, an Old Crater-Cone

Des Moines, N. Mex., where the Raton branch of the Santa Fe Railway joins the Colorado and Southern, lies at the base of Sierra Grande, a very old crater-cone and one which differs notably in shape from the younger cones of this district. Apparently it was formed by the extrusion of fluid, freely flowing lava, which built up a cone of broad base and gently sloping sides. This cone is so old that the crater has been almost wholly destroyed. Its position is marked by a hollow in the side of the peak and by the presence at the summit of red scoriaceous lava filling the old conduit which was once the throat of the volcano.

The altitude of Sierra Grande is known only approximately. According to aneroid reading it is nearly 8,500 feet, or about 2,500 feet higher than the plain on which it rests.

The clouds shown in the illustration of Sierra Grande may be worth passing mention. The mesa country is visited frequently by the short violent showers of rain and hail commonly known as "cloud-bursts." These cloud-bursts are often locally disastrous. It is not uncommon for every green thing to be destroyed by hail within a narrow belt sometimes less than a mile wide, while no damage is done on either side.

Crater-Cones of Intermediate Age

Near the very recent crater-cones of the Mt. Capulin group are several older craters. At an escarpment just north of Capulin the surface rises abruptly from the plain on which the young cones rest to a bench in the side of the mesa several hundred feet above the lower plain. This bench is a remnant of a surface which was largely eroded away to form the lower plain

and later covered with lava. It consists of sheets of basalt overlying shale, and on it are volcanic cones now partly worn away. These belong to a group of some dozen or more relatively old crater-cones, which may be called middle-aged volcanoes, as they are intermediate in age between the younger cones represented by Capulin and the still older ones represented by Sierra Grande described above. Mt. Robinson situated west of Folsom may be selected as the type of this middle group. It consists of highly scoriaceous lava, much of it so light in weight that it would float readily on water. Any cinders which may have once accumulated about it have disappeared. The slopes are worn to smooth soil-covered surfaces. The crater as originally formed has been modified in shape until it now resembles an inclined U.

The volcanic cones about Mt. Capulin correspond in age in a general way to the stages of mesa development. The old, deeply eroded Sierra Grande is a result of the ancient volcanism which produced the lava caps of the higher mesas. Those of middle age, represented by Mt. Robinson, correspond to the mesas of intermediate height; and the lavas from Mt. Capulin, resting on the recently eroded plain and on the floor of the youngest canyons of the region, correspond in age to the last cycle of erosion.

At one point in the Canyon of the Dry Cimarron I was fortunate enough to get a photograph (Fig. 13) showing three generations of lava flows. An ancient volcanic cone called Emery's Peak stands northeast of Folsom near the rim of this canyon. Ages ago basaltic lavas extruded from it, flowed over the rim, and accumulated on the floor of the canyon. Later erosion deepened the canyon many hundreds of feet, but the old bed of lava was not entirely removed. Some of it still remains as a broad shelf in the side of the canyon. At a still later time a stream of molten lava from Capulin or from one of the neighboring craters flowed down the canyon. Remnants of this lava flow remain as the dark-colored craggy masses on the present canyon floor.